New Opportunities in Long Baseline Interferometry: Observing with the VLTI

by Andrea Richichi, ESO

Catherine Cesarsky and Andrea Richichi on a short baseline

Long-baseline interferometry is often regarded as black magic rather than regular astronomical science. Bringing together the light from two distant telescopes and correcting the different optical paths to a fraction of a wavelength in spite of atmospheric turbulence, is a task with sufficient technological challenge to scare away most astronomers. However, in the morning of July 21, the IAU Working Group on Optical/IR Interferometry gathered together in Promenade Room 2 and discussed the big steps being taken to make interferometry a standard tool for every astronomer.

Chaired by P. Lawson from JPL, the meeting saw a succession of presentations which all seemed to have a common theme of cooperation and dissemination of information. A. Quirrenbach (Leiden Observatory) discussed the European Interferometry Inititiative, which includes institutes from 15 countries in a 4 year program aimed at joint research, researcher exchanges and organization of schools and workshops.

A. Richichi (European Southern Observatory) and A. Boden (Michelson Science Center) presented the specialized software tools and the lists of calibrators being assembled on the two sides of the Atlantic for the needs of the new giant interferometers Keck (Hawaii) and VLTI (Paranal). Both stressed the benefits of sharing the insider knowledge of their respective groups. Good intentions confronted reality when T. Pauls (Naval Research Laboratory) illustrated the new Data Exchange Format, which will permit the complicated data structures produced by interferometry to be exchanged across the world.

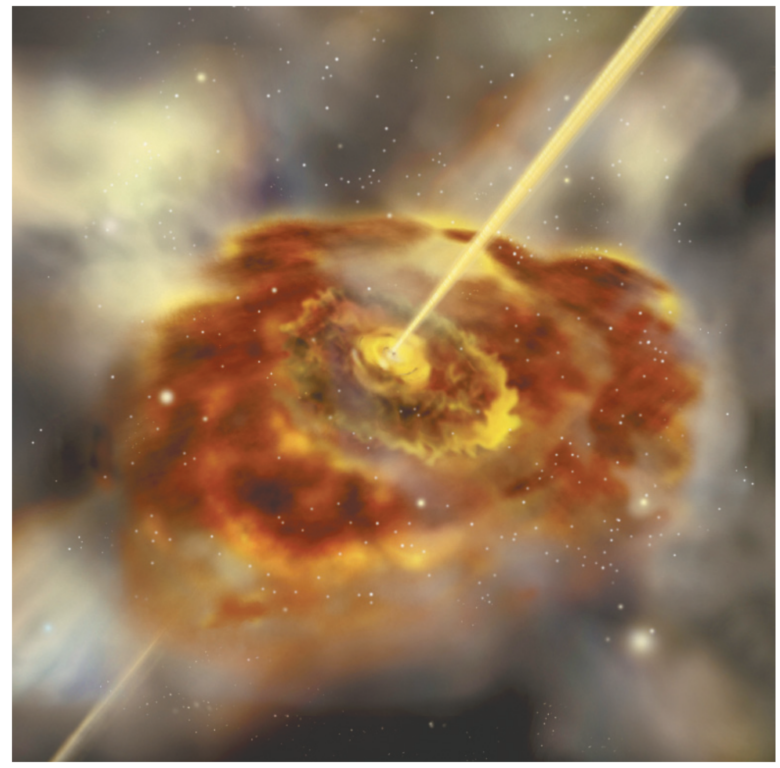
Already today, half a dozen different facilities are equipped to exchange their data in this fashion, a breakthrough simply inconceivable just a few years ago. This will permit researchers to analyze the data taken with one interferometer at another, using different software and thereby opening new possibilities to double-check results and foster new collaborations.

This session of the Working Group was perfectly timed to match two important events which took place in recent weeks:

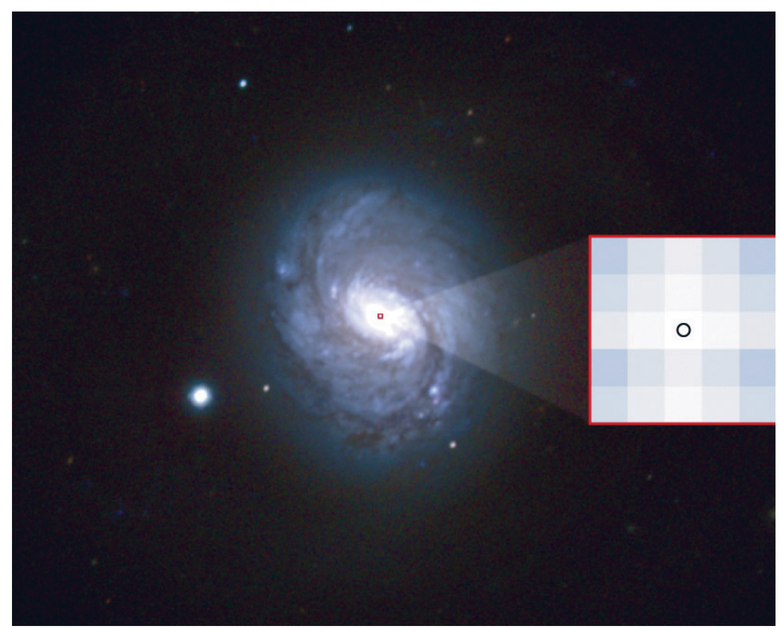
- The Keck group is celebrating the first scientific paper based on data obtained with their interferometer, a study of the young star DG Tau (Akeson et al. 2003).
- The VLTI managed to obtain for the first time interferometric fringes in the thermal infrared on an extragalactic object, the nucleus of the AGN galaxy NGC 1068, using the recently commissioned MIDI instrument (ESO PR 17/03).

The future of ground-based interferometry looks promising, with a number of large facilities being inaugurated or expanded: in addition to the Keck and the VLTI, these include the NPOI, CHARA, IOTA, and Australian-based SUSI interferometers to mention just some. In this group, the VLTI is noted for its commitment to make interferometry a tool for every astronomer. Since its first fringes in early 2001 with the VINCI instrument (a 2-way K-band beam combiner led by the Observatory of Paris), the VLTI has observed almost uninterruptedly with either small siderostats or with the large 8.2 m VLT telescopes. All on-sky commissioning data (almost 10,000 observations!) are being made public at regular intervals, and are being used by several groups, resulting in a number of papers already published even before the first observations with the regular facility instruments (see URL). These latter are MIDI (a 2-way 10-micron beam combiner led by Max-Planck-Institute for Astronomy), and AMBER (a 3-way near-IR beam combiner led by the University of Nice). MIDI is about to be offered for regular observing proposals, while AMBER will see its first light next year. These instruments will work like any other VLT instrument, with data being processed by automatic pipelines, quality-checked, and delivered to the observers in a standard format. Proposers will use the standard ESO forms, and both visiting and service observations will be possible. Interferometry will finally feel like any other astronomical technique.

The future of high-angular resolution holds the promise of many new discoveries, and the meeting of July 21 was a clear indication that these goods are in store not just for the black-belts of interferometry, but for any interested astronomer. Keep tuned!



An artist's impression of an active galaxy that has jets. The central engine is thought to be a supermassive black hole surrounded by an accretion disc and enshrouded in a dusty doughnut-shaped torus. The torus of dust and gas can be seen orbiting a flatter disc of swirling gas. In the centre, the supermassive black hole is surrounded by a flat accretion disc of rapidly orbiting material. The jets are emitted at right angles from the plane of the disc. Courtesy Aurore Simonnet, Sonoma State University.



An image of NGC 1068 taken in the visible wavelength range (courtesy NOAO/AURA/NSF). The image has 820x680 pixels. A blow-up of the central 5x5 pixels is displayed inside the figure on the right. The circle on the central pixel indicates the size of the structure that was observed with MIDI

An Elliptical Liquid Core for the Moon

by Alexander Gusev

Alexander Gusev, liquid to the core.

The nearness of the moon to the Earth allows the use of a wide variety of scientific methods for its investigation. Traditional astrophysical data (albedo, spectral and magnetic analyses) are combined with results obtained by geophysical (seismic ranging) and geochemical methods, with laser ranging data and spacecraft experiments (Apollo 1969, Galileo 1989-1991, Clementine 1994, Lunar Prospector 1998) etc.

Global topographic and gravitational field models derived from data collected by the last two missions reveal a new picture of the shape and internal structures of the moon.

These data give evidence of a liquid lunar core. The investigation of the two-layer Moon can have application to explanations of some observed phenomena, such as the great dissipation of the lunar body obtained from lunar laser ranging (LLR), the existence of free lunar libration in the presence of great dissipation, and, at last, the great gravitational signatures at the thick continental areas of the far side.The presence of a layered lunar structure, discovered from seismic studies, indicates melting and differentiation in the past.

An improved gravity field from the Lunar Prospector gives a value for the moment-of-inertia factor equal to 0.3931+/- 0.0002, and it was found that the radius of an Fe core is 320 +50/-100 km and its mass is 1.4 +0.8/-0.9 % of the Moon's mass. The corresponding radius and mass of an FeS core are 510 +80/-180 km and 3.5 +1.9/-2.6 %, respectively. From additional LLR data and and an improved gravity field from Lunar Prospector we have for a liquid iron core an estimated core radius of 352 km. For a Fe-Fes eutectic composition, the radius would be 374 km (Williams 2001.)

The study of the lunar physical libration and in particular the free core nutation of the moon (Petrova, Gusev 2001) gives one more observational opportunity to clarify the question of lunar core characteristics. There is an enticing prospect in this regard presented by the RISE and ILOM projects of the SELENE I, B, and II missions (Japan, 2005). These data will allow us to improve the physical libration theory of the moon, and together with theoretical and observational libration data will enhance futher study of the lunar interior and, as a consequence, the moon's origin and evolution.

Comet 67P/Churyumov-Gerasimenko to be Targeted

by Klim Churyumov

Rosetta, a European space vehicle 15 years in development, will head for the short period comet 67P/Churyumov-Gerasimenko in March, 2004.

In September, 1969 I went to the Alma-Ata Astrophysical Institute with fellow astronomer Svetlana Gerasimenko to conduct a survey of short period and new comets. Later that month, I examined an exposure of comet P/Comas Sol· made by Svetlana Gerasimenko on September 11.92 UT, and found a cometary object near the edge of the plate which I assumed was the expected periodic comet. Later investigations at Kiev University revealed that this comet's position was 1.8° from the predicted calculations.

The comet had an apparent magnitude of 13, the diameter of its coma was 6 arcmin, and the diameter of its central condensation was about 0.3 arcmin across. There was a faint tail about 1 arcmin in length at position angle 280 degrees. Additional position observations conducted by astronomer Nikolay Belyaev from Saint-Petersbourg showed that the comet followed an elliptical orbit. In 1982, it came closest to the Earth at 0.3910 AU.

The Rosetta Space Mission will obtain valuable information about the chemical composition and the physical and geometrical properties of the comet, data that will help to solve the fundamental scientific problem of the origin and evolution history of our solar system.